ELASTIC ELECTRON SCATTERING BY COHERENTLY PREPARED ^{138}Ba (...6s6p $^1P_1$) ATOMS; DIFFERENTIAL CROSS SECTIONS AND ALIGNMENT CREATION

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Electon scattering by laser-excited atoms opened up new possibilities in recent years for obtaining cross sections and electron impact coherence parameters (EICP's) involving excited atoms[1]. Recent developments in plasma polarization spectroscopy [2,3] have pointed out the need for laboratory data concerning creation, destruction and transfer of alignment in atomic ensembles try electron collision. One of the question raised is: can elastic collision of electrons (with anisotropic velocity distributions) create Polarization in an initially unpolarized atomic ensemble[4-6]?

We carried out a preliminary investigation of elastic scattering of electrons by an ensemble of ^{138}Ba (...6s6p $^1P_1$) atoms coherently prepared by excitation with linearly polarized laser light. Measurements were made concerning the. dependence. of elastic scattering intensity cm the polarization dire.c(icrn (ψ) in the 10 to 80 eV energy ssnd 10° to 40° angular ran. ges with a beam/beam scattering geometry and in-plane laser beam. One earl extract EICP's and/or magnetic sublevel differential cross sections (DCS's) from these studies using the Macek-Hertel formalism[7,8]. The magnetic sublevel DCS's, which can be obtained, com.spend to an elastic scattering process where the initial $^1P_1$ state is unpolarized (isotropic) and for the final $^1P_1$ state the magnetic sublevel quantum number (M_f) is specified (that is averaging over initial magnetic sublevels (M_i) and continuum electron spin are implied). We dc.note these cross sections as DCS (M_f). The reference frame. here corresponds to the inverse collision frame. Measurements along this line are in progress. We found that the. elastic scattering intensity exhibits a strong modulation as a function of ψ indicating significant dependence of the DCS (M_f)'s on M_f. These cross sections will be needed over a wide angular range at each impact energy 10 allow us integration for obtaining the integral magnetic sublevel cross sections Q(M_f) which are needed for the. calculation of the alignment creation cross sections ($Q^{[2]}$). We can not make definite statements, based on these preliminary experiments, as yet concerning the magnitude of the integral elastic magnetic sublevel cross sections Q(M_f = O) and Q(M_f = 1) which are needed to obtain the alignment creation cross section. The indications are, however. that modulation and systematic difference between magnetic sublevel DCS will persist and result in alignment creation.

From the measurements described above, we also obtained DCS's for elastic scattering by $^1P_1$ (M_i = O) and $^1P_1$ (M_i = coherent superposition of ±1) ^{138}Ba atoms These cross sections correspond to elastic scattering by atoms initially in a specific magnetic sublevel slate (M_i) and with no information available concerning M_f. Here incoherent summation over M_f and averaging over the continuum electron spin are implied and the reference frame is the collision frame corresponding [0 the experiment (forward process). We denote these cross sections as DCS (M_i). In addition. the same type of measurements were carried out in such a way that the laser beam was moved below the scattering plane. (upstream the Ba beam) yielding elastic DCS for the metastable ^{138}Ba species. These results as well as comparison with elastic DCS's for ground state Ba atoms are shown in Fig. 1.

The underlying theoretical principles and available experiment results will be presented.

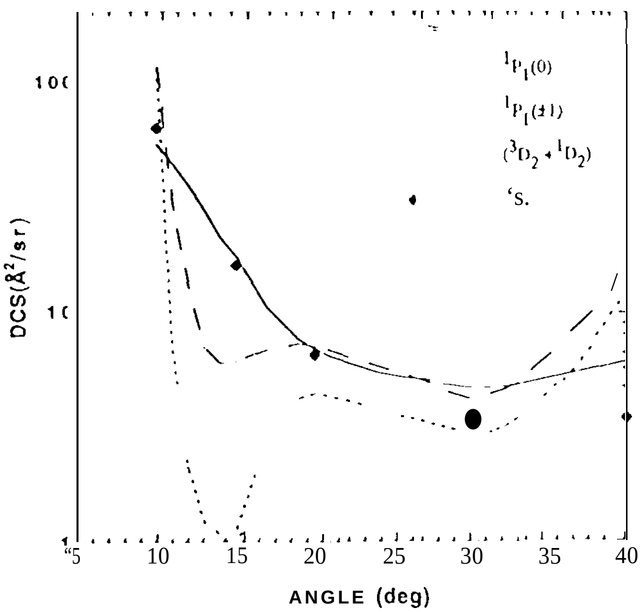

Fig. 1. Elastic differential cross sections at 20 eV electron-impact energy.

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